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Kanada et al.

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(54) **INKJET PRINTING HEAD**

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(51) **Int. Cl.**
B41J 2/045 (2006.01)

(52) **U.S. Cl.** **347/71**; 347/72

(58) **Field of Classification Search** 347/20, 347/54, 68, 70–72; 29/25.35
See application file for complete search history.

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(57) **ABSTRACT**

An inkjet printing head including: a common ink chamber having an outlet; and an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber, wherein the common ink chamber and the individual ink flow path are formed of a plurality of thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction, and wherein sectional area of the common ink chamber along a planar direction of the thin plate members is configured to be smaller at an end portion where the outlet is provided than at a central portion in a direction of thickness of the plurality of thin plate members.

15 Claims, 12 Drawing Sheets

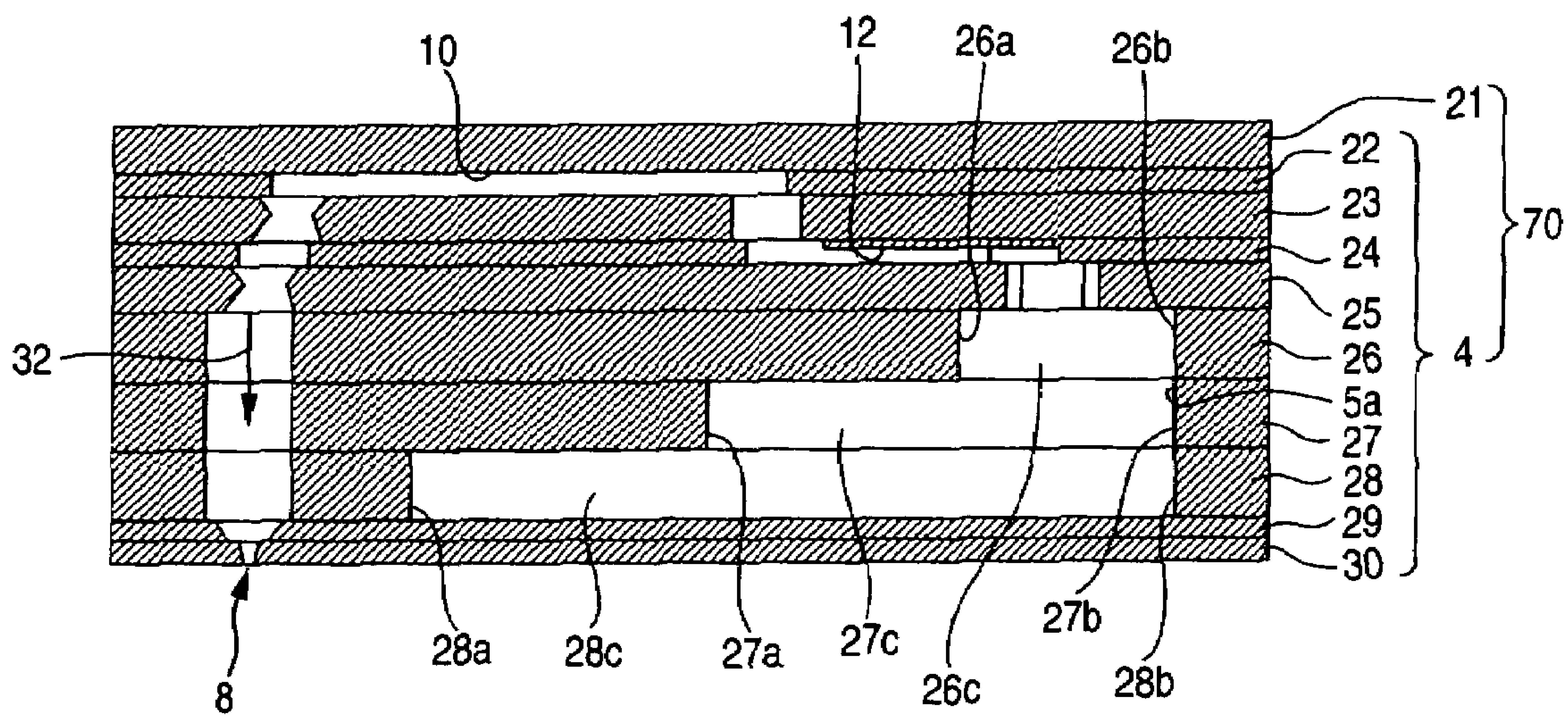


FIG. 1

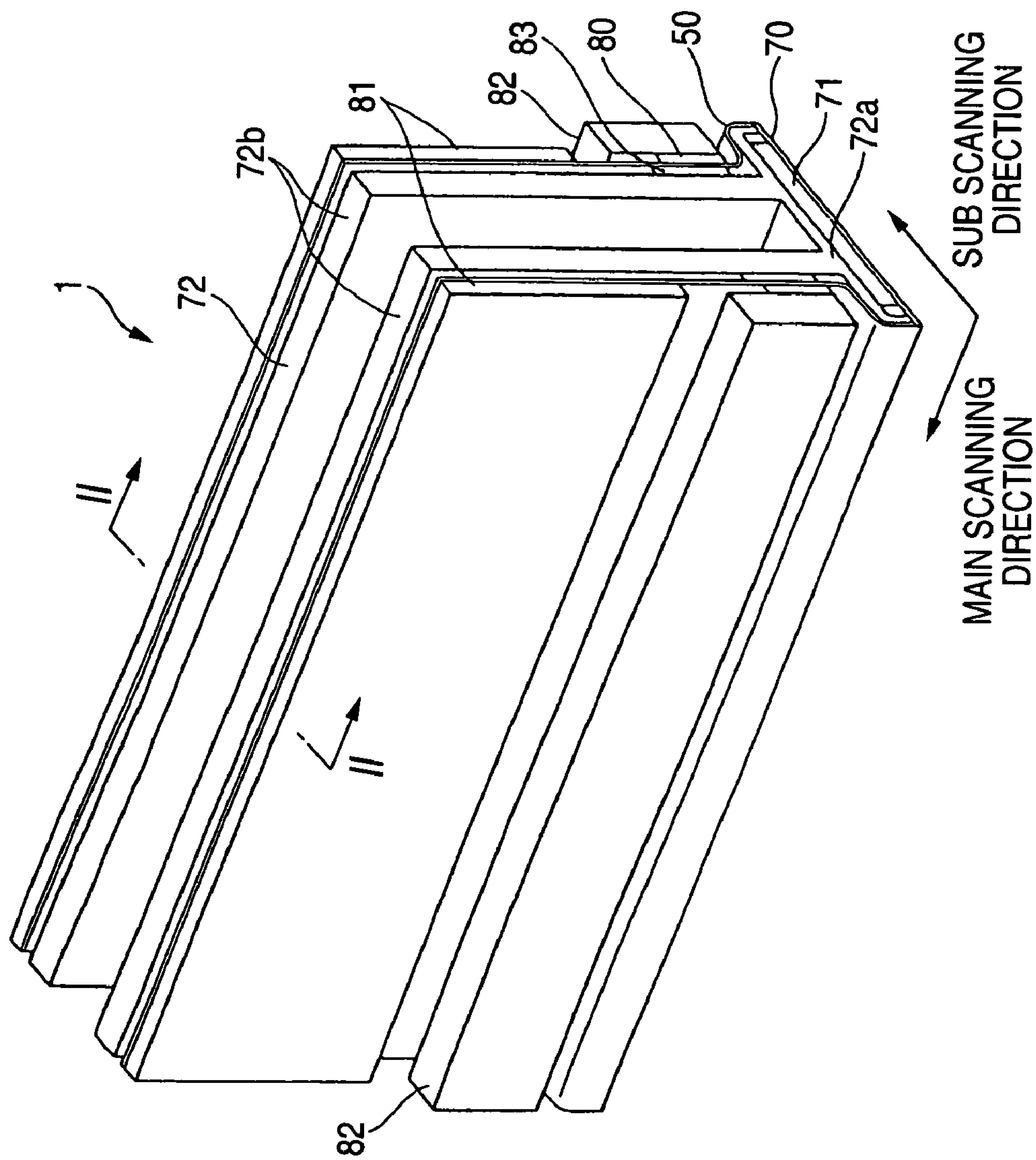
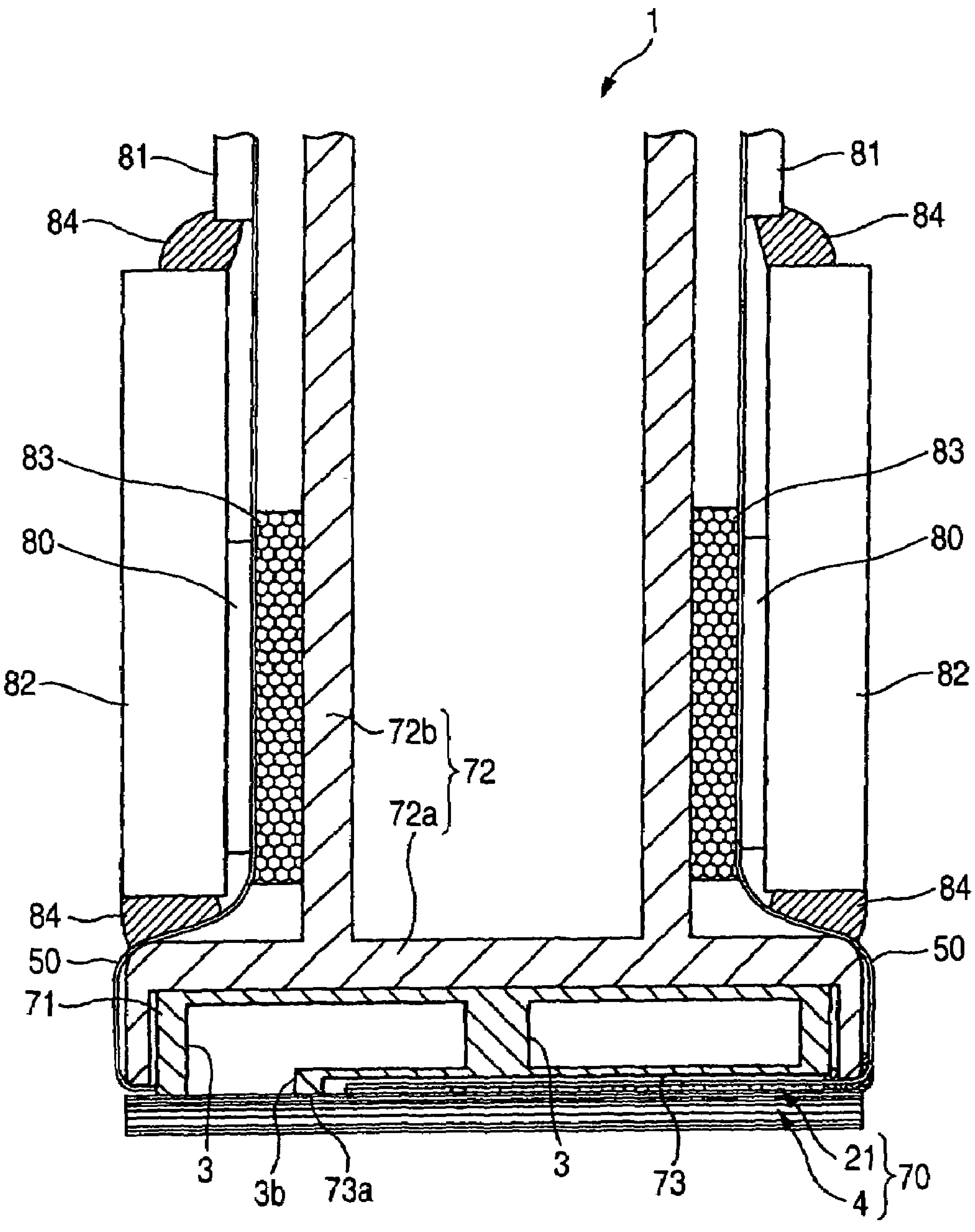

1
72
72b
81
82
83
80
50
70
71
72a
II
II
82
SUB SCANNING DIRECTION
MAIN SCANNING DIRECTION

FIG. 2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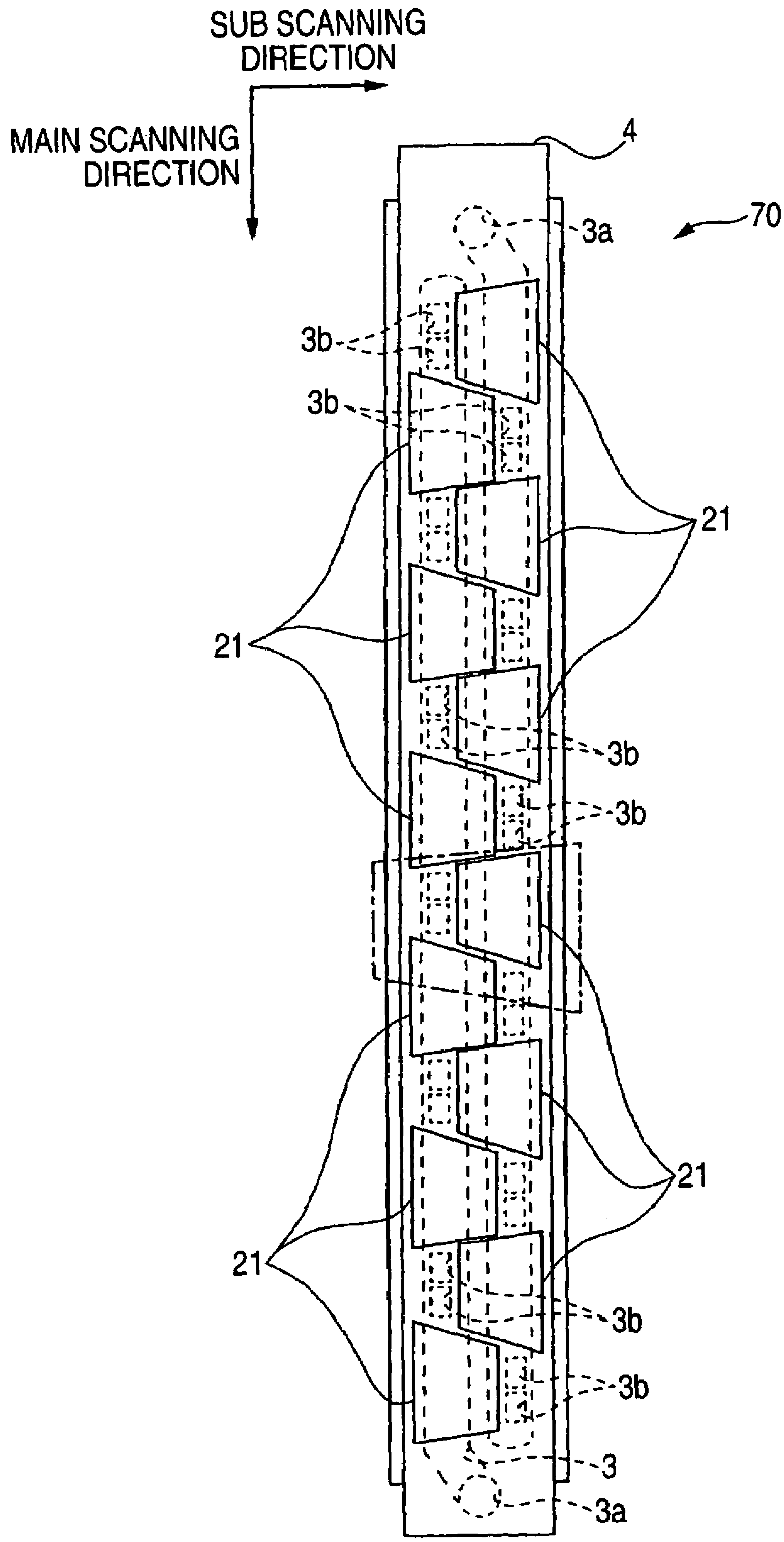
3
3b
73a
3
73
21
70
4

FIG. 3


SUB SCANNING DIRECTION
MAIN SCANNING DIRECTION
4
70
3a
3b
3b
21
21
3b
3b
21
21
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3b
3
3a

FIG. 4

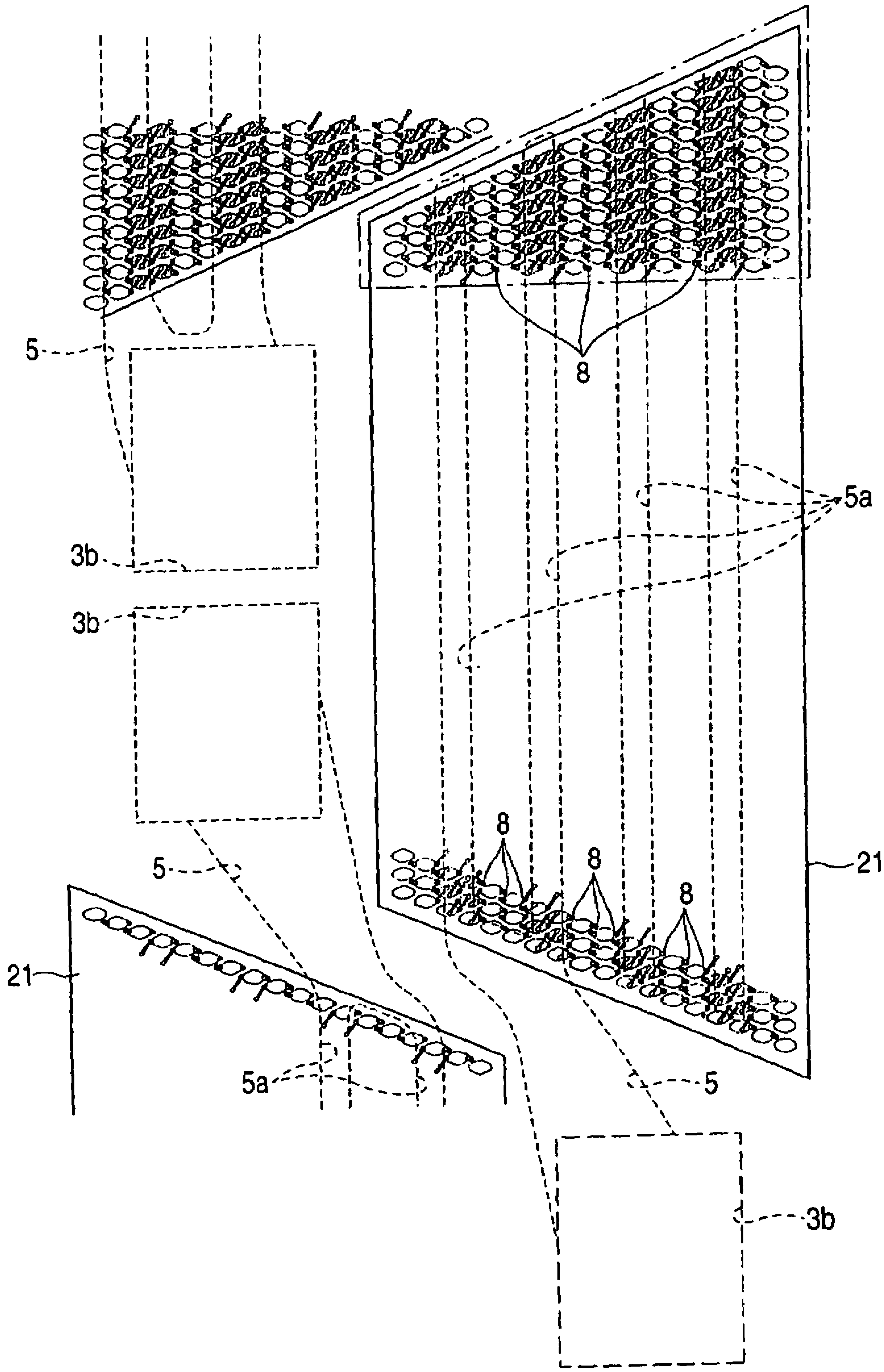


FIG. 5

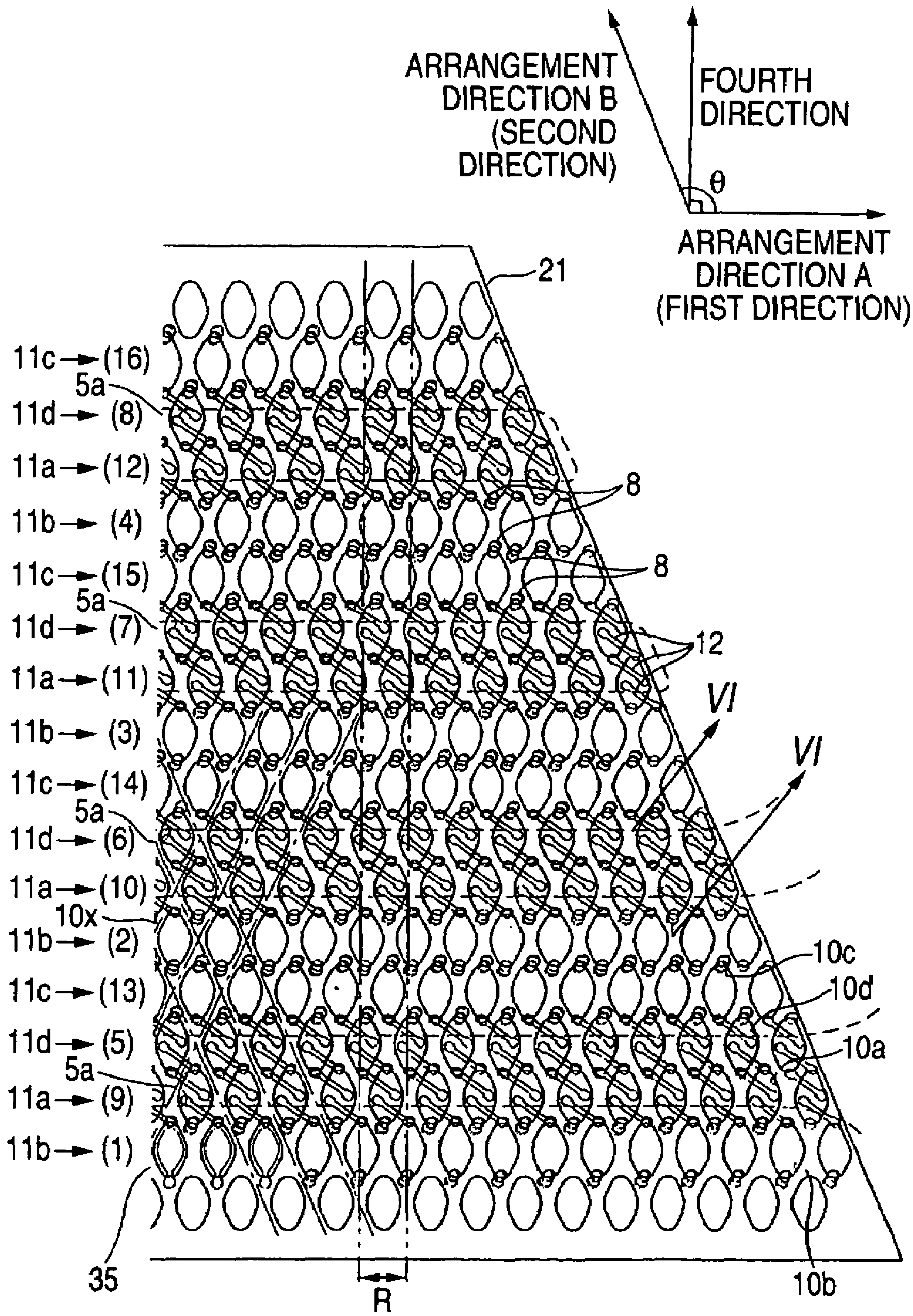

ARRANGEMENT DIRECTION B (SECOND DIRECTION)
FOURTH DIRECTION
θ
ARRANGEMENT DIRECTION A (FIRST DIRECTION)
21
11c→(16)
5a
11d→(8)
11a→(12)
11b→(4)
11c→(15)
5a
11d→(7)
11a→(11)
11b→(3)
11c→(14)
5a
11d→(6)
11a→(10)
10x
11b→(2)
11c→(13)
11d→(5)
5a
11a→(9)
11b→(1)
8
8
12
VI
VI
10c
10d
10a
35
R
10b

FIG. 6

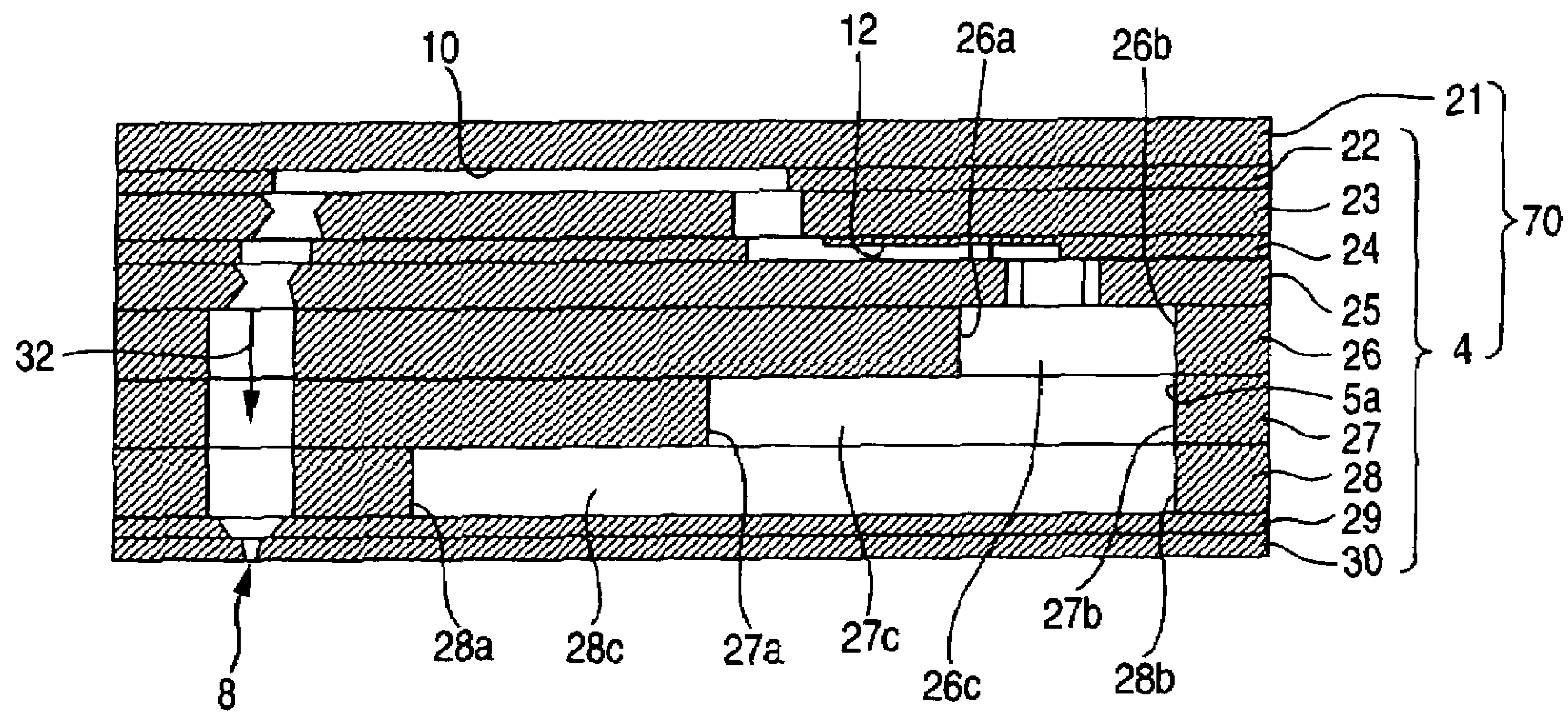

10
12
26a
26b
21
22
23
24
25
26
5a
27
28
29
30
70
4
32
8
28a
28c
27a
27c
26c
27b
28b

FIG. 7

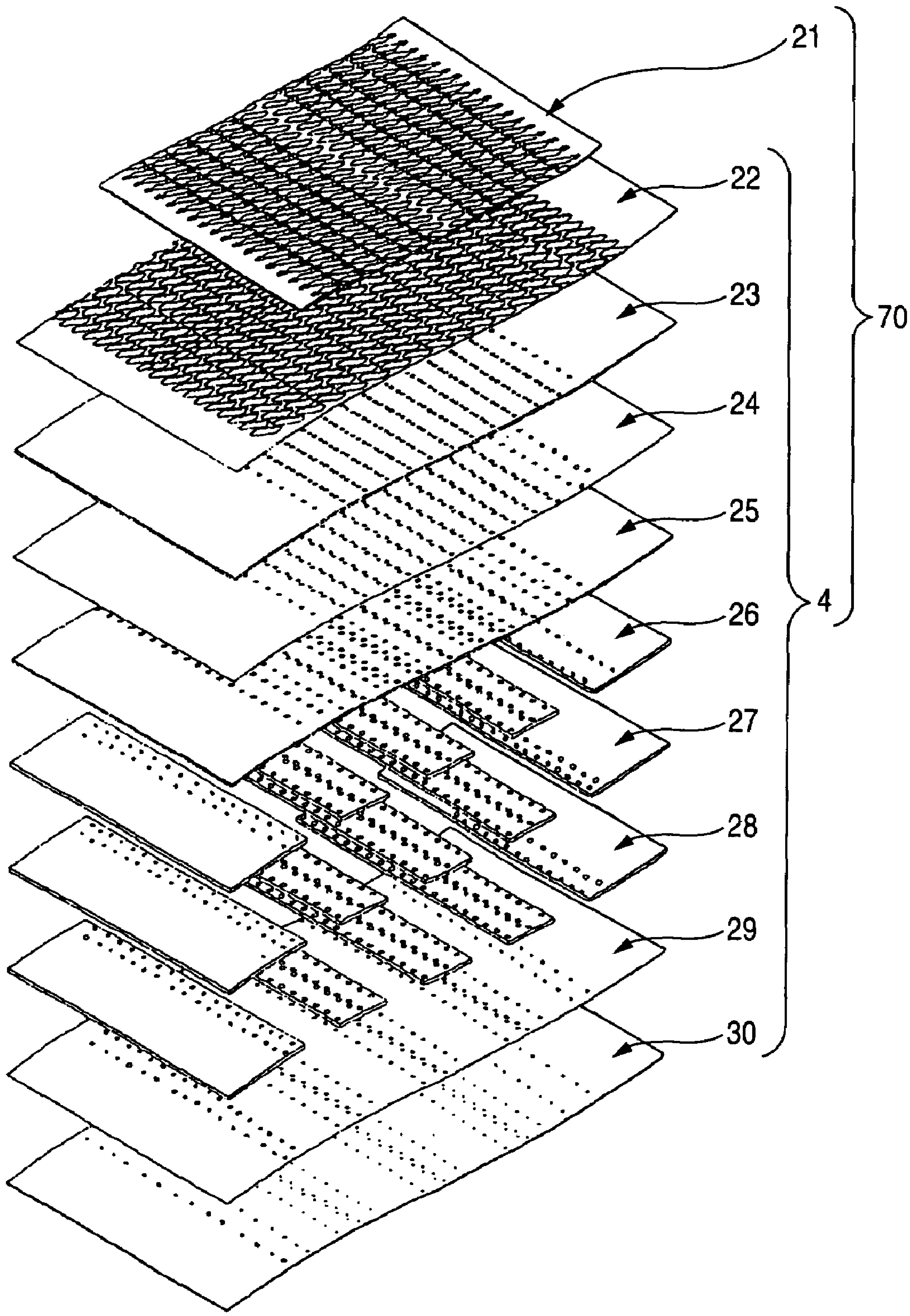


FIG. 8A

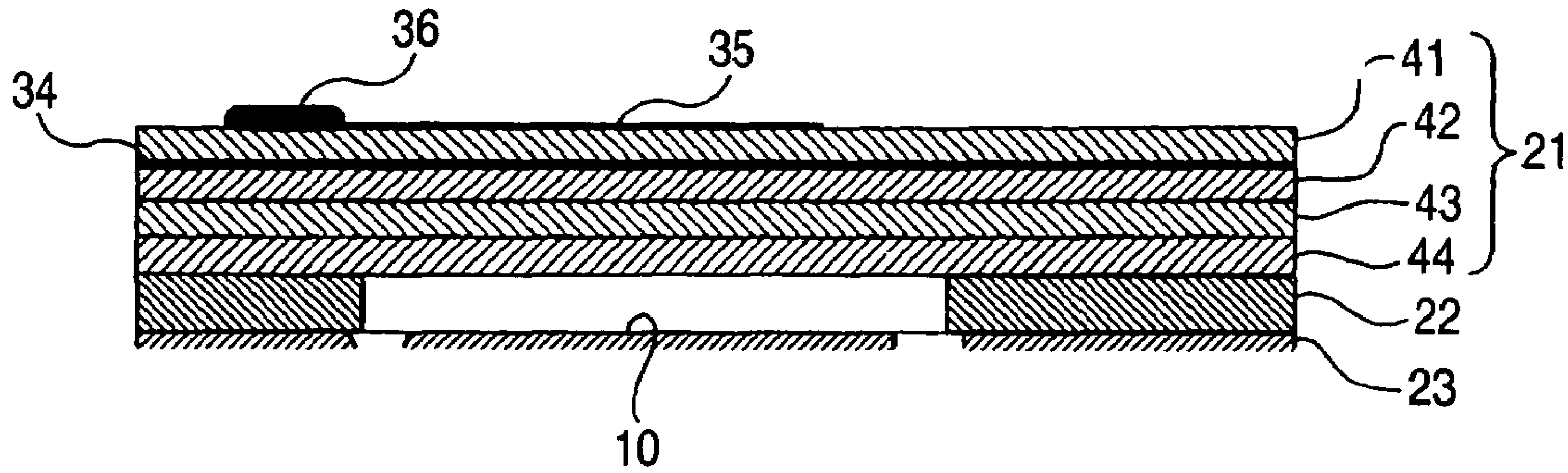


FIG. 8B

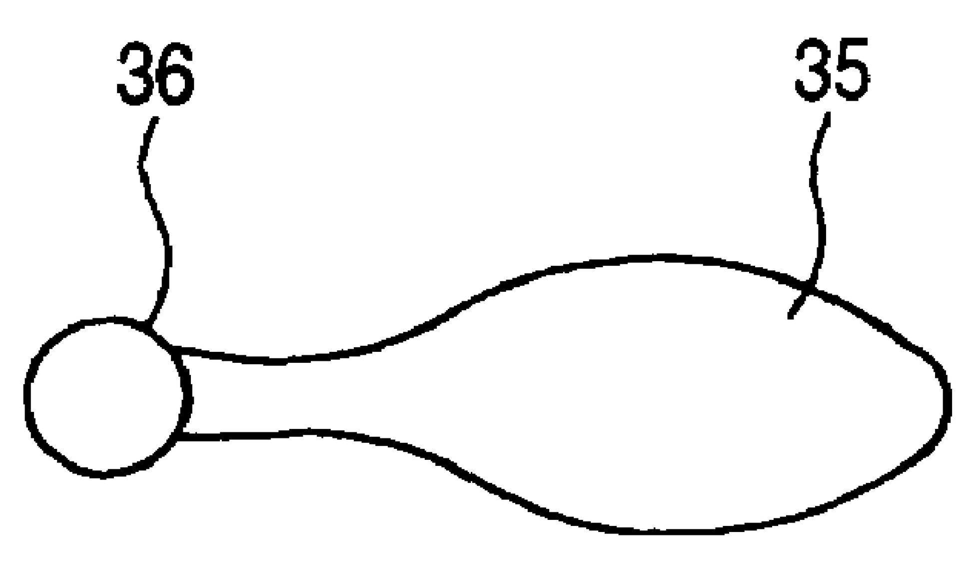


FIG. 9A

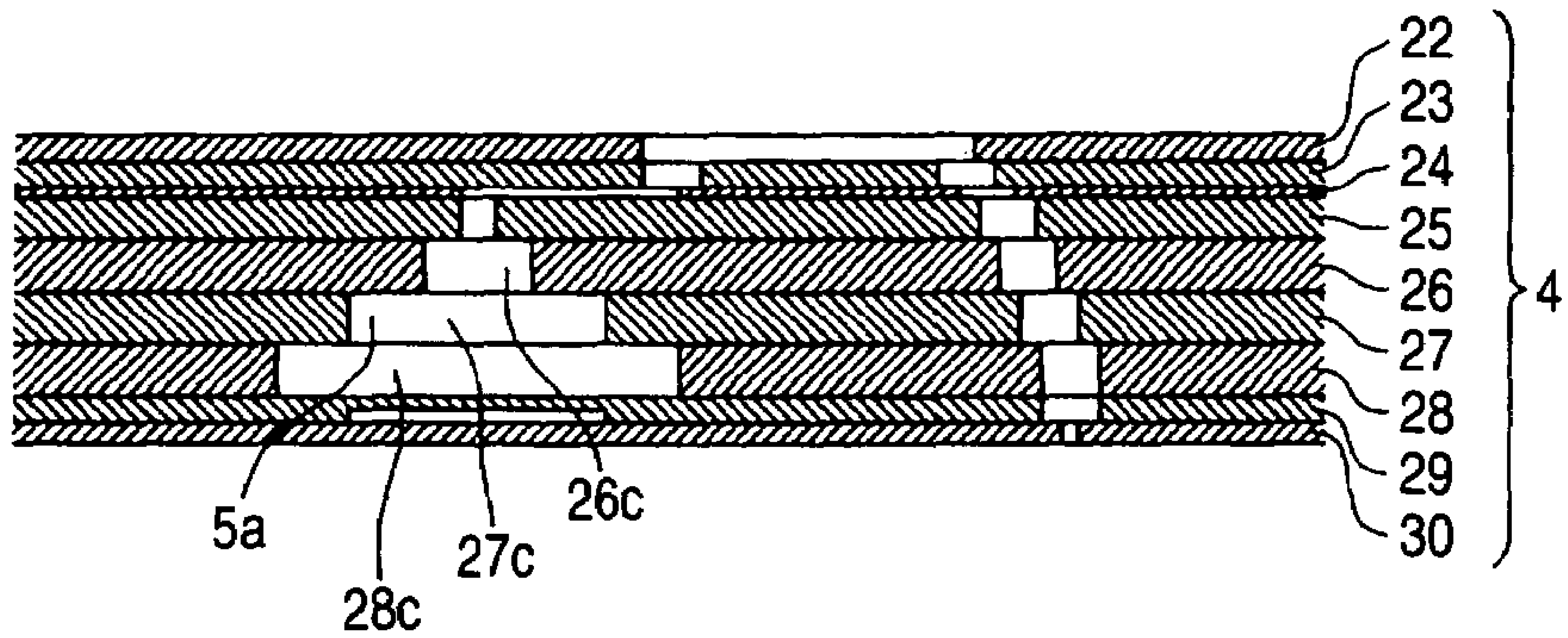


FIG. 9B

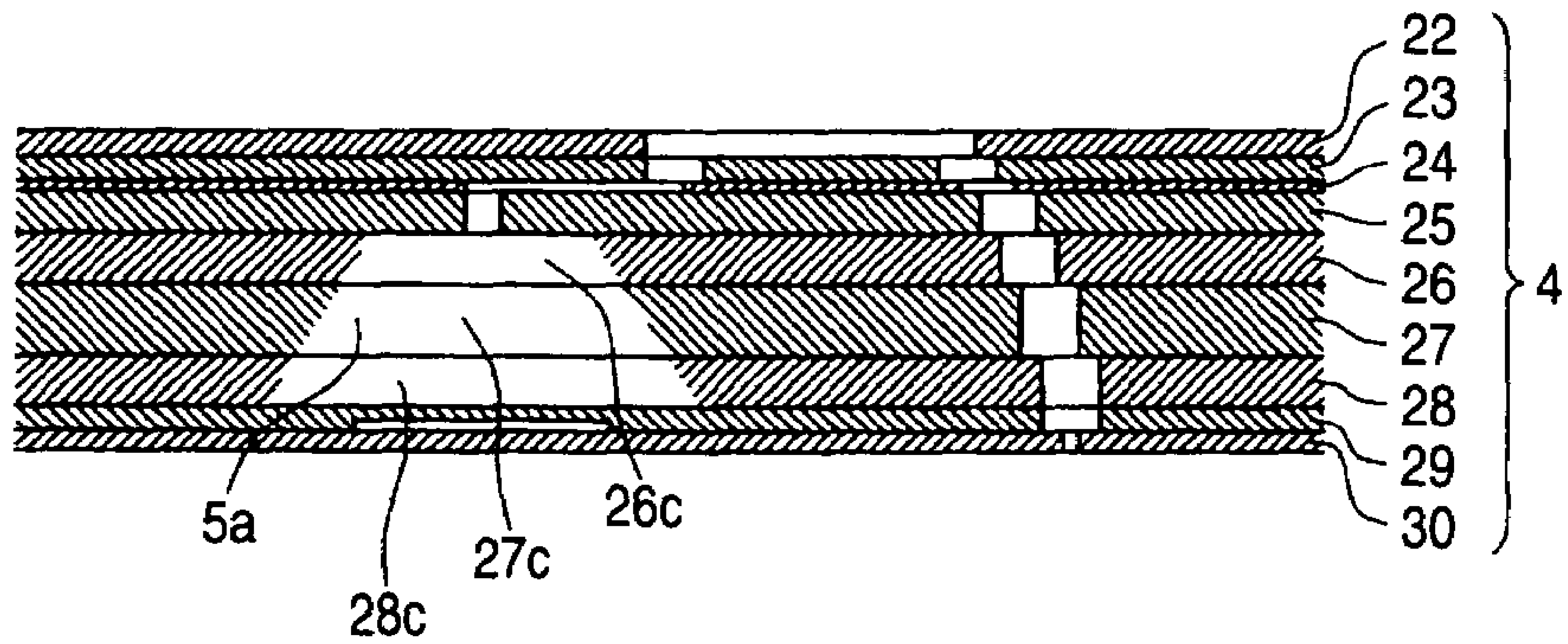


FIG. 9C

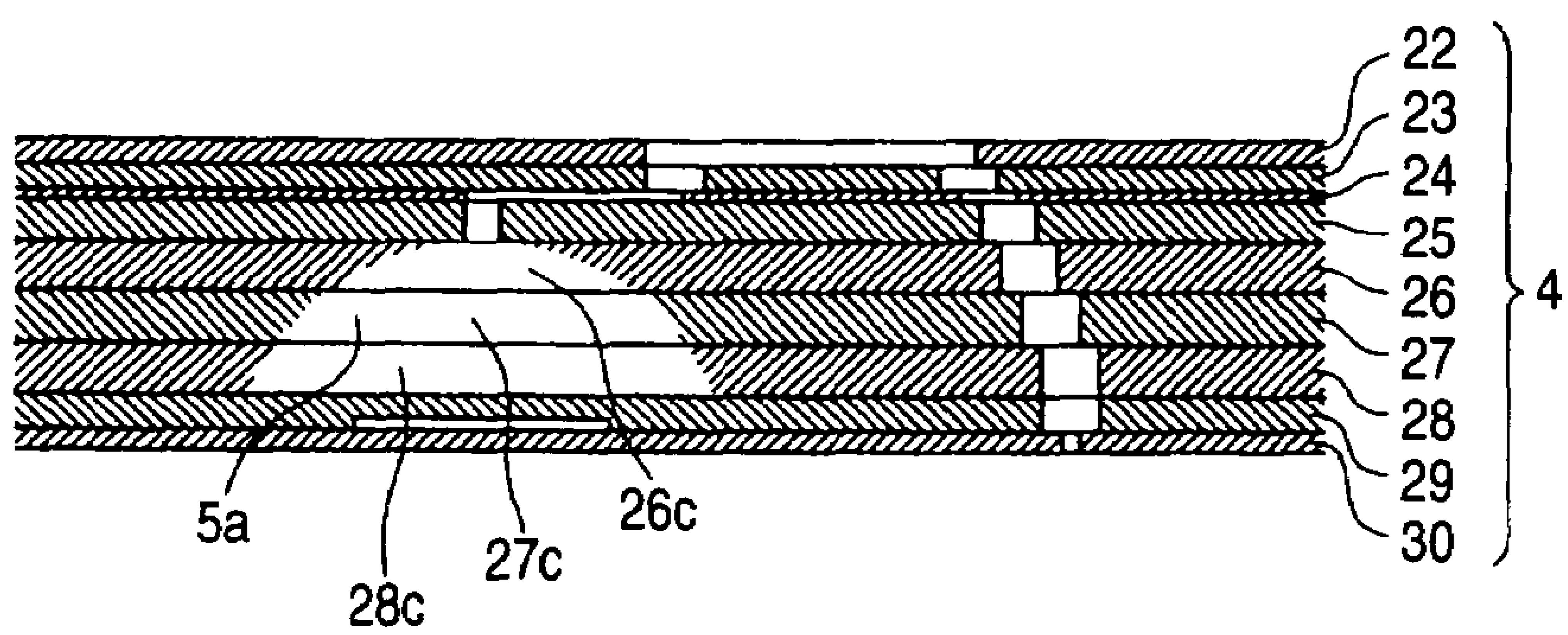


FIG. 9D

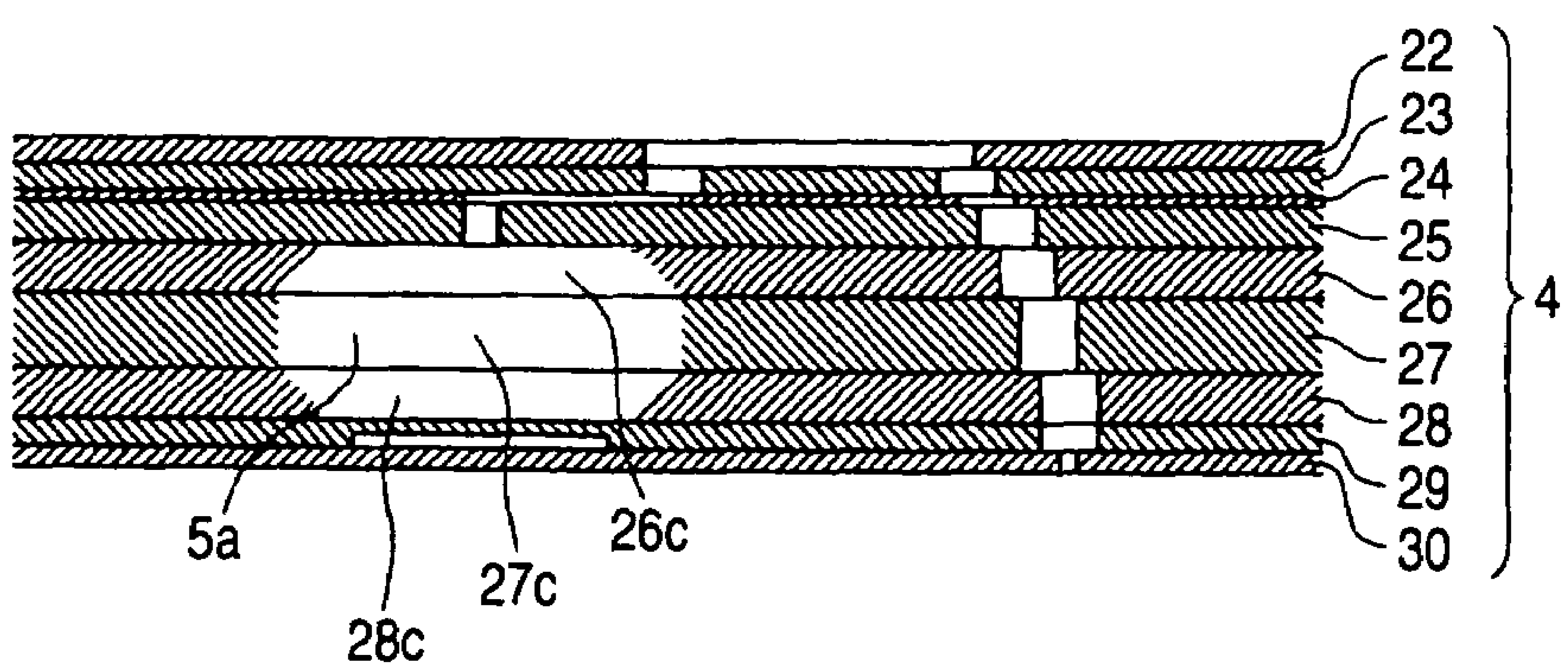


FIG. 10

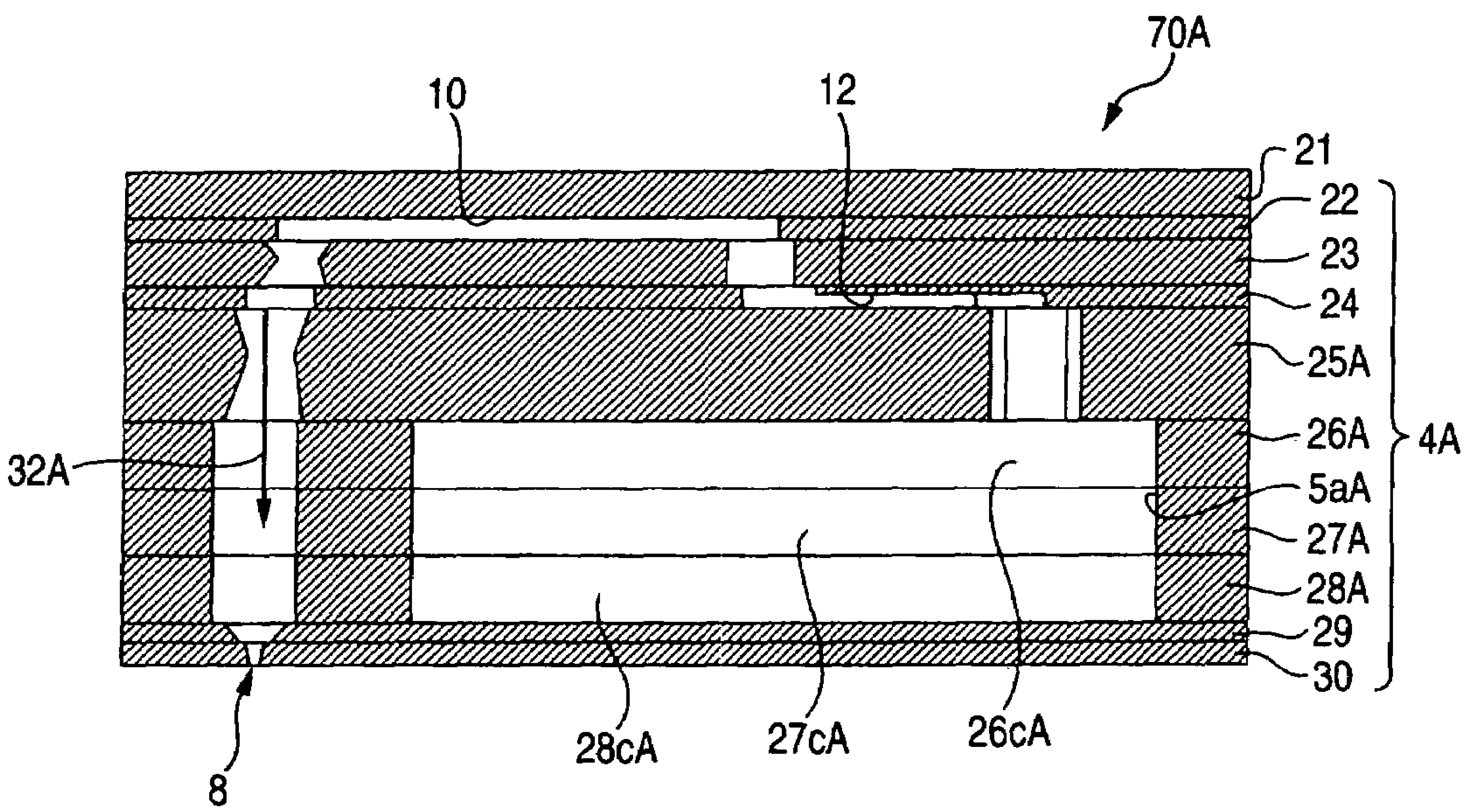

70A
10
12
21
22
23
24
25A
26A
5aA
27A
28A
29
30
4A
32A
8
28cA
27cA
26cA

FIG. 11

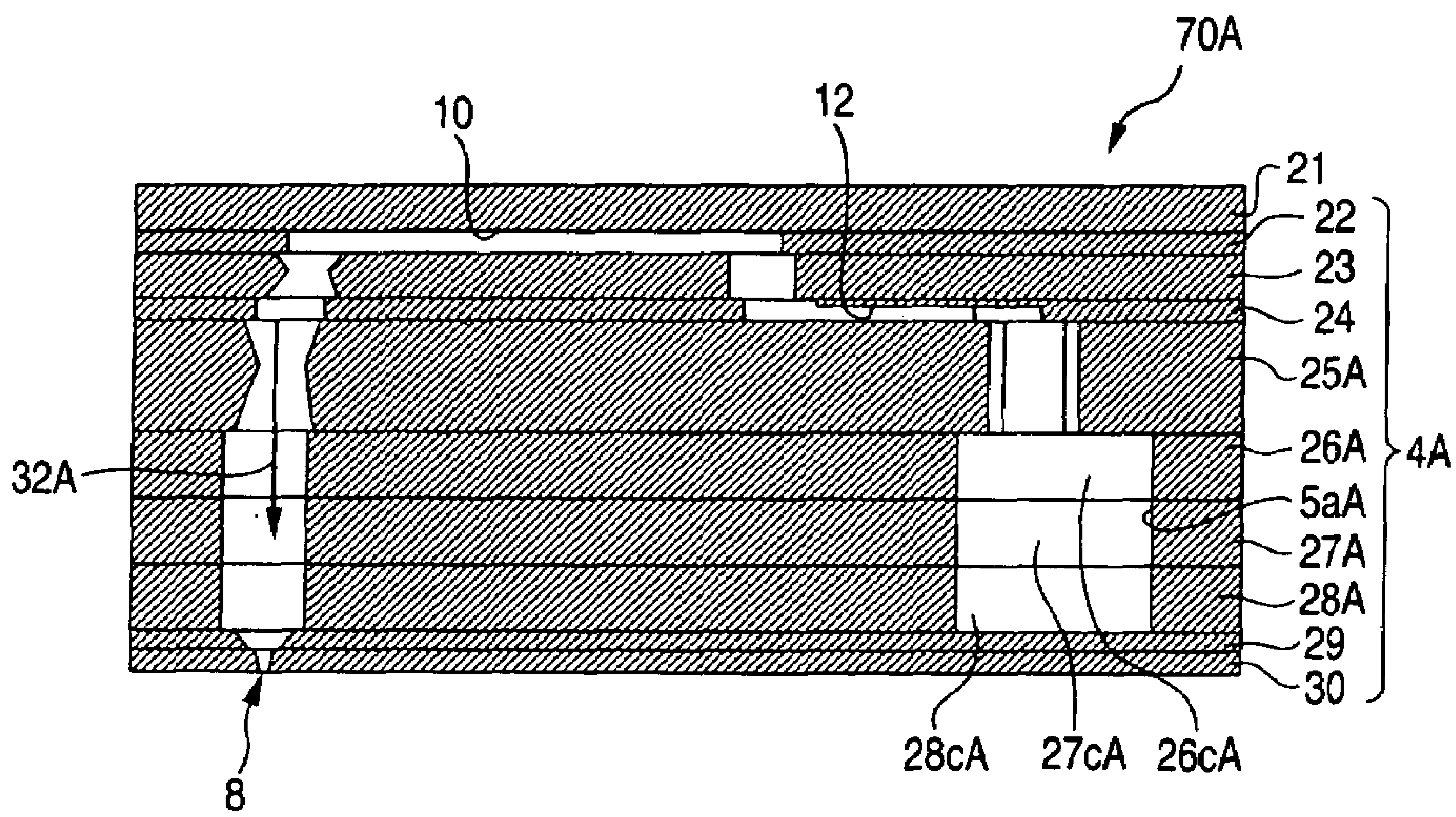

70A
10
12
21
22
23
24
25A
26A
4A
5aA
27A
28A
29
30
32A
8
28cA
27cA
26cA

FIG. 12

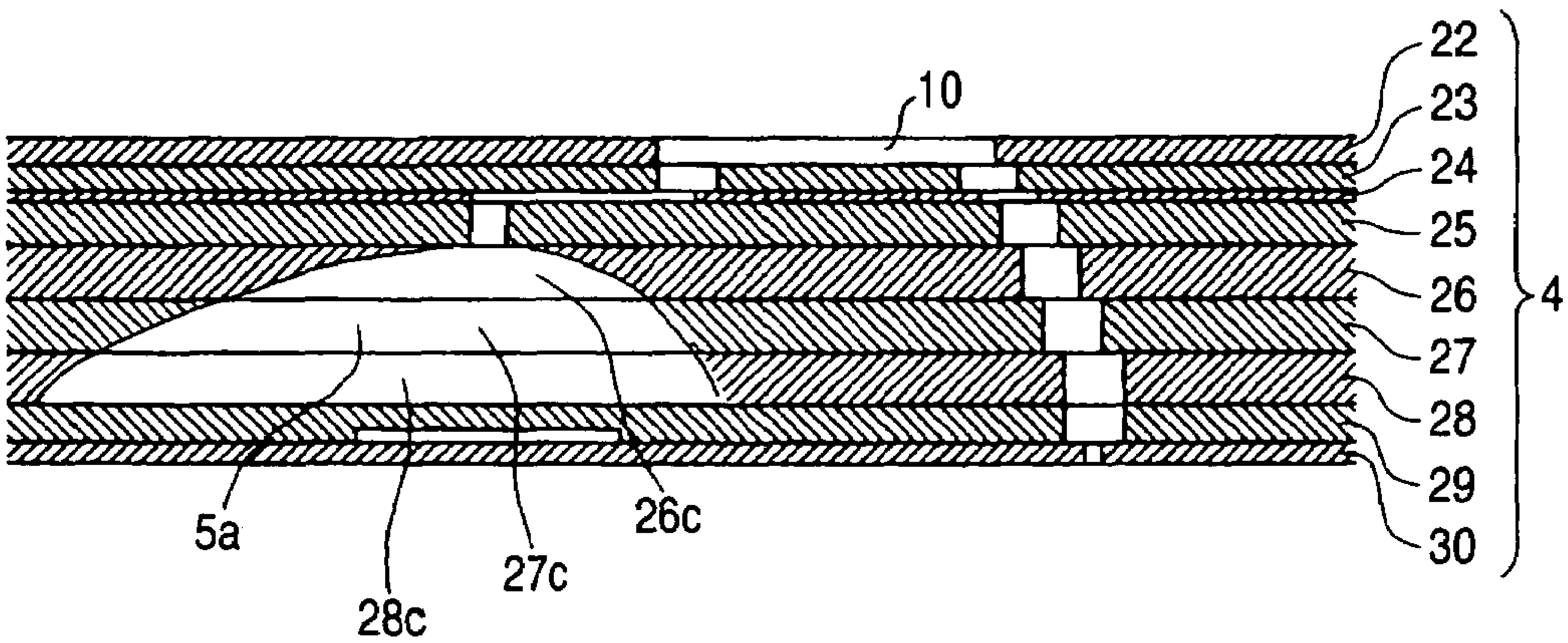
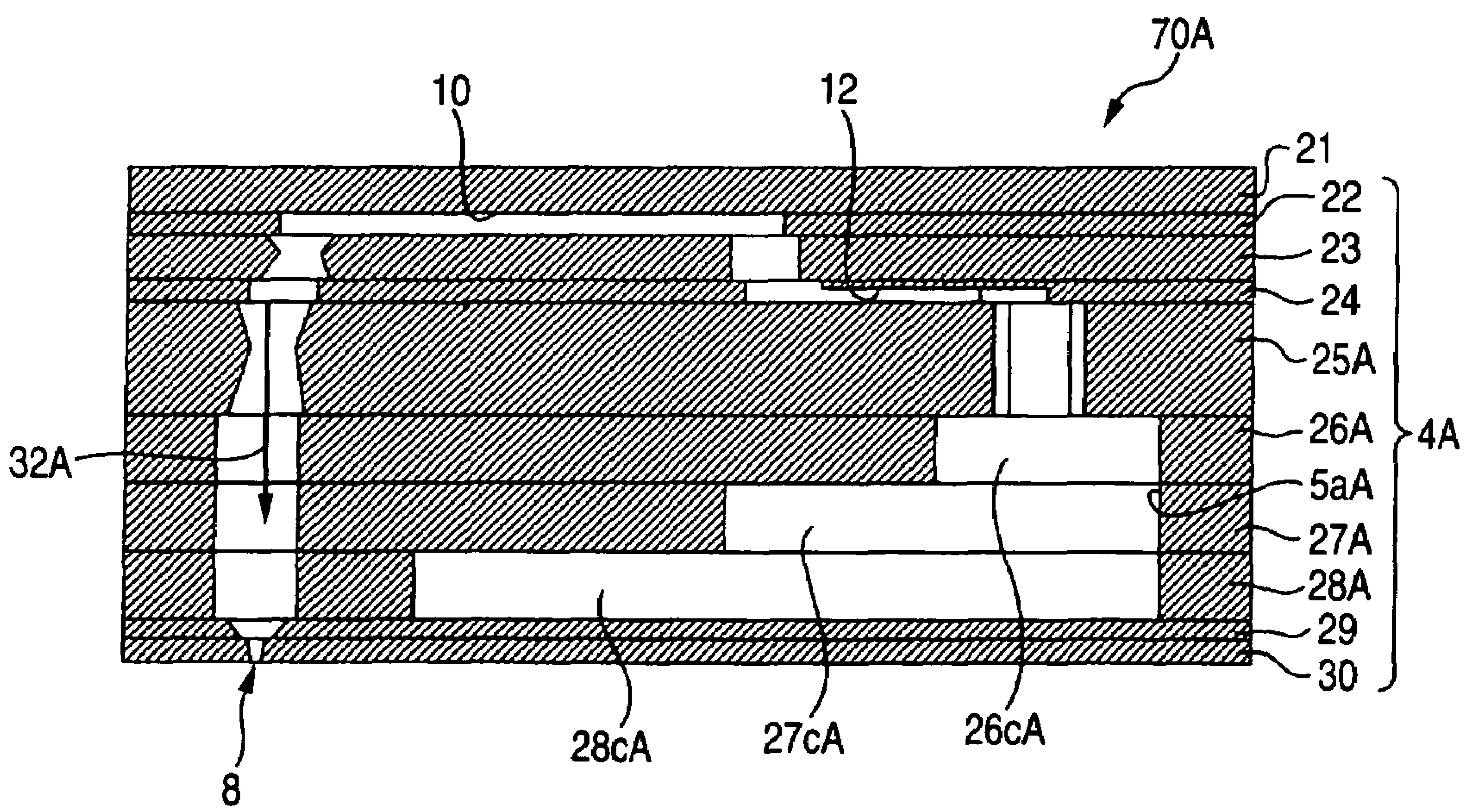

10
22
23
24
25
26
27
28
29
30
4
5a
28c
27c
26c

FIG. 13


70A
10
12
21
22
23
24
25A
26A
5aA
27A
28A
29
30
4A
32A
8
28cA
27cA
26cA

INKJET PRINTING HEAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an inkjet printing head for ejecting ink onto a recording medium to thereby perform printing.

2. Description of the Related Art

An inkjet printer includes at least one inkjet printing head having nozzles disposed therein so that ink can be ejected from the nozzles to apply printing onto a printing medium. In such an inkjet printing head, it is necessary to form complex and accurate ink flow paths in the inside of the inkjet printing head. Therefore, the inkjet printing head is formed by lamination of thin plate-like etching plates. To laminate and bond the etching plates on one another surely, for example, use of an adhesive agent such as an epoxy adhesive agent, a polyimide adhesive agent or an acrylic adhesive agent may be thought of. However, when the amount of the adhesive agent applied is large, the adhesive agent may flow into ink flow paths formed in the inside of the inkjet printing head. As a result, there is a possibility that the ink flow paths will be narrowed or blocked with the adhesive agent. Therefore, an inkjet printing head produced in such a manner that thin plate-like etching plates are laminated and bonded onto one another by diffusion junction which is one method of metal-metal junction has been proposed (e.g., see JP-A-UM-58-147749 (1983)). According to this technique, the thin plate-like etching plates can be bonded to one another with strong bonding force while the ink flow paths can be prevented from being narrowed or blocked because the adhesive agent is not used so that a surplus of the adhesive agent does not flow into the ink flow paths.

SUMMARY OF THE INVENTION

In a bonding process using metal-bonding, it is necessary to apply a predetermined pressure in a bonding direction onto a subject of bonding in a vacuum atmosphere. However, if such a predetermined pressure is applied in a bonding direction of the etching plates when a large-size ink flow path (common ink chamber) having a large opening is formed in the inside of the inkjet printing head, the etching plate laminated so as to be adjacent to the common ink chamber cannot be supported in a direction opposite to the direction of application of the pressure. As a result, the etching plate is distorted so as to be curved convexly toward the common ink chamber. Accordingly, a gap is formed between the etching plate adjacent to the common ink chamber and another etching plate adjacent to the etching plate, so that the predetermined pressure in the bonding direction cannot be applied on the portion of the gap. For this reason, it is impossible to obtain a sufficient bonding strength between the etching plate adjacent to the common ink chamber and another etching plate adjacent to the etching plate. In addition, reliable metal-bonding cannot be achieved because the size of other ink flow paths formed from these etching plates may be deformed.

Therefore, one of objects of the invention is to provide an inkjet printing head in which even in the case where a common ink chamber is formed in the inside of the inkjet printing head, a plurality of thin plate members adjacent to the common ink chamber can be fixed to one another by metal-metal junction surely.

According to a first aspect of the invention, there is provided an inkjet printing head including: a common ink chamber having an outlet; and an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber, wherein the common ink chamber and the individual ink flow path are formed of a plurality of thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction, and wherein sectional area of the common ink chamber along a planar direction of the thin plate members is configured to be smaller at an end portion where the outlet is provided than at a central portion in a direction of thickness of the plurality of thin plate members.

According to a second aspect of the invention, there is provided an inkjet printing head including: a common ink chamber having an outlet; and an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber, wherein the common ink chamber and the individual ink flow path are formed of a plurality of thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction, and wherein a thickest one of a part of the plurality of thin plate members that are laminated above the common ink chamber at a side to the pressure chamber, is positioned at a side to the common ink chamber in the part of the plurality of thin plate members with respect to a central position of the part of the plurality of thin plate members.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention will become more fully apparent from the following detailed description taken with the accompanying drawings, in which:

FIG. **1** is a perspective view of an inkjet printing head according to a first embodiment of the invention;

FIG. **2** is a sectional view taken along the line II-II in FIG. **1**;

FIG. **3** is a plan view of a head body included in the inkjet printing head depicted in FIG. **2**;

FIG. **4** is an enlarged view of a region surrounded by the chain line shown in FIG. **3**;

FIG. **5** is an enlarged view of a region surrounded by the chain line shown in FIG. **4**;

FIG. **6** is a sectional view taken along the line VI-VI in FIG. **5**;

FIG. **7** is a partially exploded perspective view of the head body depicted in FIG. **6**;

FIG. **8**A is an enlarged view of an actuator unit depicted in FIG. **6**, and FIG. **8**B is an enlarged view of each individual electrode mounted on the actuator unit;

FIGS. **9**A to **9**D are sectional views showing modifications of the head body of the inkjet printing head depicted in FIG. **1**;

FIG. **10** is a sectional view of the head body of the inkjet printing head according to a second embodiment of the invention;

FIG. **11** shows a modification of the head body depicted in FIG. **10**;

FIG. **12** is a sectional view showing another modifications of the head body of the inkjet printing head; and

FIG. **13** is a sectional view of the head body of the inkjet printing head according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the accompanying drawings, a description will be given in detail of preferred embodiments of the invention.

First Embodiment

A preferred embodiment according to a first embodiment of the invention will be described below with reference to the drawings.

FIG. **1** is a perspective view showing the external appearance of an inkjet printing head according to a first embodiment. FIG. **2** is a sectional view taken along the line II-II in FIG. **1**. The inkjet printing head **1** has a head body **70**, and a base block **71**. The head body **70** is shaped like a flat rectangle extending in a main scanning direction for ejecting ink onto a sheet of paper. The base block **71** is disposed above the head body **70** and includes ink reservoirs **3** formed as flow paths of ink supplied to the head body **70**.

The head body **70** includes a flow path unit **4**, and a plurality of actuator units **21**. An ink flow path is formed in the flow path unit **4**. The plurality of actuator units **21** are bonded onto an upper surface of the flow path unit **4**. The flow path unit **4** and actuator units **21** are formed in such a manner that a plurality of thin plate members are laminated and bonded to one another. Flexible printed circuit boards (hereinafter referred to as FPCs) **50** which are feeder circuit members are bonded onto an upper surface of the actuator units **21** and pulled out in left and right direction. The FPCs **50** are led upward while bent as shown in FIG. **2**. The base block **71** is made of a metal material such as stainless steel. Each of the ink reservoirs **3** in the base block **71** is a nearly rectangular parallelepiped hollow region formed along a direction of the length of the base block **71**.

A lower surface **73** of the base block **71** protrudes downward from its surroundings in neighbors of openings **3***b*. The base block **71** touches the flow path unit **4** (shown in FIG. **3**) only at neighbors **73***a* of the openings **3***b* of the lower surface **73**. For this reason, all other regions than the neighbors **73***a* of the openings **3***b* of the lower surface **73** of the base block **71** are isolated from the head body **70** so that the actuator units **21** are disposed in the isolated portions.

The base block **71** is bonded and fixed into a cavity formed in a lower surface of a grip **72***a* of a holder **72**. The holder **72** includes a grip **72***a*, and a pair of flat plate-like protrusions **72***b* extending from an upper surface of the grip **72***a* in a direction perpendicular to the upper surface of the grip **72***a* so as to form a predetermined distance between each other. The FPCs **50** bonded to the actuator units **21** are disposed so as to go along surfaces of the protrusions **72***b* of the holder **72** through elastic members **83** such as sponge respectively. Driver ICs **80** are disposed on the FPCs **50** disposed on the surfaces of the protrusions **72***b* of the holder **72**. The FPCs **50** are electrically connected to the driver ICs **80** and the actuator units **21** (will be described later in detail) by soldering so that drive signals output from the driver ICs **80** are transmitted to the actuator units **21** of the head body **70**.

Nearly rectangular parallelepiped heat sinks **82** are disposed closely on outer surfaces of the driver ICs **80**, so that heat generated in the driver ICs **80** can be radiated efficiently. Boards **81** are disposed above the driver ICs **80** and the heat sinks **82** and outside the FPCs **50**. Seal members **84** are disposed between an upper surface of each heat sink **82** and a corresponding board **81** and between a lower surface of each heat sink **82** and a corresponding FPC **50** respectively. That is, the heat sinks **82**, the boards **81** and the FPCs **50** are bonded to one another by the seal members **84**.

FIG. **3** is a plan view of the head body included in the inkjet printing head depicted in FIG. **1**. In FIG. **3**, the ink reservoirs **3** formed in the base block **71** are drawn virtually by the broken line. Two ink reservoirs **3** extend in parallel to each other along a direction of the length of the head body **70** so as to form a predetermined distance between the two ink reservoirs **3**. Each of the two ink reservoirs **3** has an opening **3***a* at its one end. The two ink reservoirs **3** communicate with an ink tank (not shown) through the openings **3***a* so as to be always filled with ink. A large number of openings **3***b* are provided in each ink reservoir **3** along the direction of the length of the head body **70**. As described above, the ink reservoirs **3** are connected to the flow path unit **4** by the openings **3***b*. The large number of openings **3***b* are formed in such a manner that each pair of openings **3***b* are disposed closely along the direction of the length of the head body **70**. The pairs of openings **3***b* connected to one ink reservoir **3** and the pairs of openings **3***b* connected to the other ink reservoir **3** are disposed in zigzag.

The plurality of actuator units **21** each having a trapezoid flat shape are disposed in regions where the openings **3***b* are not provided. The plurality of actuator units **21** are disposed in zigzag so as to have a pattern reverse to that of the pairs of openings **3***b*. Parallel opposed sides (upper and lower sides) of each actuator unit **21** are parallel to the direction of the length of the head body **70**. Inclined sides of adjacent actuator units **21** partially overlap each other in a direction of the width of the head body **70**.

FIG. **4** is an enlarged view of a region surrounded by the chain line in FIG. **3**. As shown in FIG. **4**, the openings **3***b* provided in each ink reservoir **3** communicate with manifolds **5** which are common ink chambers respectively. An end portion of each manifold **5** branches into two sub manifolds **5***a*. In plan view, every two sub manifolds **5***a* separated from adjacent openings **3***b* extend from two inclined sides of each actuator unit **21**. That is, four sub manifolds **5***a* in total are provided below each actuator unit **21** and extend along the parallel opposed sides of the actuator unit **21** so as to be separated from one another.

Ink ejection regions are formed in a lower surface of the flow path unit **4** corresponding to the bonding regions of the actuator units **21**. As will be described later, a large number of nozzles **8** are disposed in the form of a matrix in a surface of each ink ejection region. Although FIG. **4** shows several nozzles **8** for the sake of simplification, nozzles **8** are actually arranged on the whole of the ink ejection region.

FIG. **5** is an enlarged view of a region surrounded by the chain line in FIG. **4**. FIGS. **4** and **5** show a state in which a plane of a large number of pressure chambers **10** disposed in the form of a matrix in the flow path unit **4** is viewed from a direction perpendicular to the ink ejection surface. Each of the pressure chambers **10** is shaped substantially like a rhomboid having rounded corners in plan view. The long diagonal line of the rhomboid is parallel to the direction of the width of the flow path unit **4**. Each pressure chamber **10** has one end connected to a corresponding nozzle **8**, and the other end connected to a corresponding sub manifold **5***a* as a common ink flow path through an aperture **12**. An individual electrode **35** having a planar shape similar to but size smaller than that of each pressure chamber **10** is formed on the actuator unit **21** so as to be adjacent to the pressure chamber **10** in plan view. Some of a large number of individual electrodes **35** are shown in FIG. **5** for the sake of simplification. Incidentally, the pressure chambers **10** and apertures **12** that must be expressed by the broken line in the actuator units **21** or in the flow path unit **4** are expressed by the solid line in FIGS. **4** and **5** to make it easy to understand the drawings.

In FIG. **5**, a plurality of virtual rhombic regions **10** in which the pressure chambers **10** are stored respectively are disposed adjacently in the form of a matrix both in an arrangement direction A (first direction) and in an arrangement direction B (second direction) so that adjacent virtual rhombic regions **10**x have common sides not overlapping each other. The arrangement direction A is a direction of the length of the inkjet printing head **1**, that is, a direction of extension of each sub manifold **5**a. The arrangement direction A is parallel to the short diagonal line of each rhombic region **10**x. The arrangement direction B is a direction of one inclined side of each rhombic region **10**x in which an obtuse angle θ is formed between the arrangement direction B and the arrangement direction A. The central position of each pressure chamber **10** is common to that of a corresponding rhombic region **10**x but the contour line of each pressure chamber **10** is separated from that of a corresponding rhombic region **10**x in plan view.

The pressure chambers **10** disposed adjacently in the form of a matrix in the two arrangement directions A and B are formed at intervals of a distance corresponding to 37.5 dpi along the arrangement direction A. The pressure chambers **10** are formed so that eighteen pressure chambers **10** are arranged in the arrangement direction B in one ink ejection region. Pressure chambers located at opposite ends in the arrangement direction B are dummy chambers that do not contribute to ink ejection.

The plurality of pressure chambers **10** disposed in the form of a matrix form a plurality of pressure chamber columns along the arrangement direction A shown in FIG. **5**. The pressure chamber columns are separated into first pressure chamber columns **11**a, second pressure chamber columns **11**b, third pressure chamber columns **11**c and fourth pressure chamber columns **11**d in accordance with positions relative to the sub manifolds **5**a viewed from a direction (third direction) perpendicular to the paper surface of FIG. **5**. The first to fourth pressure chamber columns **11**a to **11**d are arranged cyclically in order of **11**c->**11**d->**11**a->**11**b->**11**c->**11**d->. . . ->**11**b from an upper side to a lower side of each actuator unit **21**.

In pressure chambers **10**a forming the first pressure chamber column **11**a and pressure chambers **10**b forming the second pressure chamber column **11**b, nozzles **8** are unevenly distributed on a lower side of the paper surface of FIG. **5** in a direction (fourth direction) perpendicular to the arrangement direction A when viewed from the third direction. The nozzles **8** are located in lower end portions of corresponding rhombic regions **10**x respectively. On the other hand, in pressure chambers **10**c forming the third pressure chamber column **11**c and pressure chambers **10**d forming the fourth pressure chamber column **11**d, nozzles **8** are unevenly distributed on an upper side of the paper surface of FIG. **5** in the fourth direction. The nozzles **8** are located in upper end portions of corresponding rhombic regions **10**x respectively. In the first and fourth pressure chamber columns **11**a and **11**d, regions not smaller than half of the pressure chambers **10**a and **10**d overlap the sub manifolds **5**a when viewed from the third direction. In the second and third pressure chamber columns **11**b and **11**c, the regions of the pressure chambers **10**b and **10**c do not overlap the sub manifolds **5**a at all when viewed from the third direction. For this reason, pressure chambers **10** belonging to any pressure chamber column can be formed so that the sub manifolds **5**a are widened as sufficiently as possible while nozzles **8** connected to the pressure chambers **10** do not overlap the sub manifold **5**a. Accordingly, ink can be supplied to the respective pressure chambers **10** smoothly.

Next, the sectional structure of the head body **70** will be described more specifically with reference to FIGS. **6** and **7**. FIG. **6** is a sectional view taken along the line VI-VI in FIG. **5**. A pressure chamber **10**a belonging to a first pressure chamber column **11**a is shown in FIG. **6**. FIG. **7** is a partially exploded perspective view of the head body. As is obvious from FIG. **6**, each nozzle **8** is connected to a sub manifold **5**a through the pressure chamber **10** (**10**a) and an aperture **12**. In this manner, an individual ink flow path **32** for leading ink from an outlet of the sub manifold **5**a to the nozzle **8** through the aperture **12** and the pressure chamber **10** is formed in the head body **70** so as to be disposed in accordance with every pressure chamber **10**.

As is also obvious from FIG. **7**, the head body **70** has a laminated structure in which ten sheet materials in total are laminated on one another, that is, an actuator unit **21**, a cavity plate **22**, a base plate **23**, an aperture plate **24**, a supply plate **25**, manifold plates **26**, **27** and **28**, a cover plate **29** and a nozzle plate **30** are laminated successively in descending order. The ten sheet materials except the actuator unit **21**, that is, nine metal plates form a flow path unit **4**. The respective metal plates are collectively bonded to one another by means of diffusion junction.

As will be described later in detail, the actuator unit **21** includes a laminate of four piezoelectric sheets **41** to **44** (see FIG. **8**A) as four layers, and electrodes disposed so that only the uppermost layer is provided as a layer having a portion serving as an active layer at the time of application of electric field (hereinafter simply referred to as "active layer-including layer") while the residual three layers are provided as non-active layers. The cavity plate **22** is a metal plate having a large number of approximately rhomboid openings corresponding to the pressure chambers **10**. The base plate **23** is a metal plate which has holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding aperture **12**, and holes each for connecting the pressure chamber **10** to a corresponding ink nozzle **8**. The aperture plate **24** is a metal plate which has apertures **12** formed as half-etching regions each for connecting two holes in one pressure chamber **10** of the cavity plate **22**, and holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**.

In the embodiment, the apertures **12** serves as a restricted flow path that restricts flow of the ink and provided between the common ink chamber (manifolds **5**) and the pressure chamber **10** in the individual ink flow path.

The supply plate **25** is a metal plate which has holes each for connecting an aperture **12** for one pressure chamber **10** of the cavity plate **22** to a corresponding sub manifold **5**a, and holes each for connecting the pressure chamber **10** to the ink nozzle **8**. The manifold plates **26**, **27** and **28** are metal plates which have holes **26**c, **27**c and **28**c connected to one another at the time of lamination for forming the manifolds **5**a, and holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**. The cover plate **29** is a metal plate which has holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**. The nozzle plate **30** is a metal plate which has nozzles **8** each provided for one pressure chamber **10** of the cavity plate **22**.

These nine metal plates are laminated on one another while positioned so that individual ink flow paths **32** as shown in FIG. **6** are formed. Each of the individual ink flow paths **32** first extends upward from the sub manifold **5***a*, extends horizontally in the aperture **12**, extends further upward, extends horizontally in the pressure chamber **10** again, extends obliquely downward for a while in a direction of departing from the aperture **12** and extends vertically downward to the nozzle **8**.

Particularly, each sub manifold **5***a* serving as the common ink chamber is formed from the three holes **26***c*, **27***c* and **28***c* of the manifold plates **26**, **27** and **28** as described above. The sectional areas of the metal plates in each sub manifold **5***a* in a planar direction, that is, the opening areas of the holes **26***c*, **27***c* and **28***c* of the manifold plates **26**, **27** and **28** for forming each sub manifold **5***a* become larger stepwise (in three stages) in order of lamination of the manifold plates **26**, **27** and **28** when viewed from the aperture plate **24** side to the cover plate **29** side.

The holes **26***c*, **27***c* and **28***c* of the manifold plates **26**, **27** and **28** for forming each sub manifold **5***a* have inner walls **26***a*, **26***b*, **27***a*, **27***b*, **28***a* and **28***b* which serve as inner walls in the direction of the width of the sub manifold **5***a*. The inner walls **26***a*, **27***a* and **28***a* are inner walls on the bottom side (shown in the lower side of FIG. **5**) of the sub manifold **5***a* shaped like a trapezoid as shown in FIG. **5**. The inner walls **26***b*, **27***b* and **28***b* are inner walls on the top side (shown in the upper side of FIG. **5**) of the sub manifold **5***a*. Incidentally, a widthwise shape formed by the inner walls **28***a* and **28***b* of the manifold plate **28** is expressed as the widthwise shape of the sub manifold **5***a* shown in FIGS. **4** and **5**. The inner walls **26***a*, **27***a* and **28***a* are disposed so that the inner walls on the bottom side of the sub manifold **5***a* are shifted to the bottom side stepwise when viewed from the aperture plate **24** side to the cover plate **29** side. On the other hand, the inner walls **26***b*, **27***b* and **28***b* are disposed so that the inner walls on the upper side of the sub manifold **5***a* are aligned on a straight line. That is, the sectional shape of the sub manifold **5***a* in the widthwise direction is substantially like a right-angled triangle.

Next, the configuration of the actuator unit **21** laminated on the cavity plate **22** as the uppermost layer of the flow path unit **4** will be described. FIG. **8**A is a partially enlarged sectional view showing the actuator unit **21** and a pressure chamber **10**. FIG. **8**B is a plan view showing the shape of an individual electrode bonded to a surface of the actuator unit **21**.

As shown in FIG. **8**A, the actuator unit **21** includes four piezoelectric sheets **41**, **42**, **43** and **44** formed to have a thickness of about 15 μm equally. The piezoelectric sheets **41** to **44** are provided as stratified flat plates (continuous flat plate layers) which are continued to one another so as to be arranged over a large number of pressure chambers **10** formed in one ink ejection region in the head body **70**. Because the piezoelectric sheets **41** to **44** are arranged as continuous flat plate layers over the large number of pressure chambers **10**, the individual electrodes **35** can be disposed densely on the piezoelectric sheet **41** when, for example, a screen printing technique is used. Accordingly, the pressure chambers **10** formed in positions corresponding to the individual electrodes **35** can be also disposed densely, so that a high-resolution image can be printed. Each of the piezoelectric sheets **41** to **44** is made of a ceramic material of the lead zirconate titanate (PZT) type having ferroelectricity.

The individual electrodes **35** are formed on the piezoelectric sheet **41** as the uppermost layer. A common electrode **34** having a thickness of about 2 μm is interposed between the piezoelectric sheet **41** as the uppermost layer and the piezoelectric sheet **42** located under the piezoelectric sheet **41** so that the common electrode **34** is formed on the whole surface of the piezoelectric sheet **42**. The individual electrodes **35** and the common electrode **34** are made of a metal material such as Ag-Pd.

As shown in FIG. **8**B, each individual electrode **35** has a thickness of about 1 μm and substantially has a rhomboid shape nearly similar to the shape of the pressure chamber **10** shown in FIG. **5**. An acute-angled portion of each approximately rhomboid individual electrode **35** extends. A circular land portion **36** having a diameter of about 160 μm is provided at an end of the extension of the acute-angled portion of the individual electrode **35** so as to be electrically connected to the individual electrode **35**. For example, the land portion **36** is made of gold containing glass frit. As shown in FIG. **8**A, the land portion **36** is bonded onto a surface of the extension of the individual electrode **35**.

The common electrode **34** is grounded to a region not shown. Accordingly, the common electrode **34** is kept at ground potential equally in regions corresponding to all the pressure chambers **10**. The individual electrodes **35** are connected to the driver IC **80** through the FPC **50** including independent lead wires in accordance with the individual electrodes **35** so that electric potential can be controlled in accordance with each pressure chamber **10** (see FIGS. **1** and **2**).

Next, a drive method of the actuator unit **21** will be described. The direction of polarization of the piezoelectric sheet **41** in the actuator unit **21** is a direction of the thickness of the piezoelectric sheet **41**. That is, the actuator unit **21** has a so-called unimorph type structure in which one piezoelectric sheet **41** on an upper side (i.e., far from the pressure chambers **10**) is used as a layer including an active layer while three piezoelectric sheets **42** to **44** on a lower side (i.e., near to the pressure chambers **10**) are used as non-active layers. Accordingly, when the electric potential of an individual electrode **35** is set at a predetermined positive or negative value, an electric field applied portion of the piezoelectric sheet **41** put between electrodes serves as an active layer (pressure generation portion) and shrinks in a direction perpendicular to the direction of polarization by the transverse piezoelectric effect, for example, if the direction of the electric field is the same as the direction of polarization. On the other hand, the piezoelectric sheets **42** to **44** are not affected by the electric field, so that the piezoelectric sheets **42** to **44** are not displaced spontaneously. Accordingly, a difference in distortion in a direction perpendicular to the direction of polarization is generated between the piezoelectric sheet **41** on the upper side and the piezoelectric sheets **42** to **44** on the lower side, so that the whole of the piezoelectric sheets **41** to **44** is to be deformed so as to be curved convexly on the non-active side (unimorph deformation). On this occasion, as shown in FIG. **8**A, the lower surface of the whole of the piezoelectric sheets **41** to **44** is fixed to the upper surface of the partition wall (cavity plate) **22** which partitions the pressure chambers. As a result, the piezoelectric sheets **41** to **44** are deformed so as to be curved convexly on the pressure chamber side. For this reason, the volume of the pressure chamber **10** is reduced to increase the pressure of ink to thereby eject ink from a nozzle **8** connected to the pressure chamber **10**. Then, when the electric potential of the individual electrode **35** is returned to the same value as the electric potential of the common electrode **34**, the piezoelectric sheets **41** to **44** are restored to the original shape so that the volume of the pressure chamber **10** is returned to the original value. As a result, ink is sucked from the manifold **5** side.

According to the first embodiment described above, the pressure applied on the respective metal plates in the direction of thickness for metal-bonding the respective metal plates in regions adjacent to the sub manifolds **5***a* is successively diffused from the supply plate **25** to the manifold plates **26**, **27** and **28** for forming the sub manifolds **5***a*. For this reason, the supply plate **25** is not curved convexly toward the sub manifolds **5***a*, so that there is neither formation of a gap formed between the supply plate **25** and the aperture plate **24** nor deformation in inner shape of the ink flow paths of the apertures **12** constituted by the supply plate **25** and the aperture plate **24**. Accordingly, even in the case where the sub manifolds **5***a* are formed in the flow path unit **4**, the plurality of metal plates adjacent to the sub manifolds **5***a* can be fixed to one another by metal-metal junction surely.

In addition, because the sub manifolds **5***a* are formed in such a manner that the plurality of holes **26***c*, **27***c* and **28***c* formed in the manifold plates **26**, **27** and **28** are connected to one another, the sub manifolds **5***a* can be produced easily in the condition that each sub manifold **5***a* has a desired sectional shape.

Although the first embodiment has been described on the case where the sectional shape of each sub manifold **5***a* in the widthwise direction is substantially like a right-angled triangle, the shape of each sub manifold **5***a* is not limited as long as the sectional areas of the respective metal plates in the planar direction in each manifold **5***a* increase when viewed from the aperture plate **24** side to the cover plate **29** side. FIGS. **9**A to **9**D are sectional views showing modifications of the head body **70**. For example, as shown in FIG. **9**A, the inner walls of the holes **26***c*, **27***c* and **28***c* formed in the manifold plates **26**, **27** and **28** may be widened stepwise on the widthwise opposite sides of each sub manifold **5***a* in order of lamination of the manifold plates **26**, **27** and **28** so that the sectional shape of each sub manifold **5***a* in the widthwise direction is substantially like a triangle.

Although the modification has been described on the case where the areas of the holes **26***c*, **27***c* and **28***c* of the manifold plates **26**, **27** and **28** constituting the sub manifolds **5***a* increase stepwise in accordance with the manifold plates **26**, **27** and **28** when viewed from the aperture plate **24** side to the cover plate **29** side, the shapes of the holes **26***c*, **27***c* and **28***c* are not limited thereto. The holes **26***c*, **27***c* and **28***c* of the manifold plates **26**, **27** and **28** may be shaped so that the areas of the holes **26***c*, **27***c* and **28***c* change continuously. For example, the sectional shape of each sub manifold **5***a* in the widthwise direction may be substantially like a triangle or right-angled triangle formed from lines. The sectional shape of each sub manifold **5***a* in the widthwise direction may be like a trapezoid as shown in FIG. **9**B or like a semicircle as shown in FIG. **9**C.

Although FIG. **6** shows the configuration in which the areas of all the holes **26***c*, **27***c* and **28***c* of the three manifold plates **26**, **27** and **28** constituting the sub manifolds **5***a* change so as to increase in accordance with the order of lamination, the invention is not limited to the configuration. For example, as shown in FIG. **9**D, configuration may be made so that the areas of the holes **26***c* and **27***c* of the manifold plates **26** and **27** change so as to increase in accordance with the order of lamination while the areas of the holes **27***c* and **28***c* of the manifold plates **27** and **28** change so as to decrease in accordance with the order of lamination.

Second Embodiment

A second embodiment of the invention will be described below with reference to the drawings.

A head body **70**A according to the second embodiment corresponds to the head body **70** according to the first embodiment. The second embodiment is substantially the same as the first embodiment except the sectional structure of the head body **70**A in the second embodiment. Accordingly, only the sectional structure of the head body **70**A in the second embodiment will be described.

FIG. **10** is a sectional view taken along the line VI-VI In FIG. **5**. A pressure chamber **10***a* belonging to a first pressure chamber column **11***a* is shown in FIG. **10**. As is obvious from FIG. **10**, a nozzle **8** is connected to a sub manifold **5***a*A through the pressure chamber **10** (**10***a*) and an aperture **12**. In this manner, an individual ink flow path **32**A for leading ink from an outlet of the sub manifold **5***a*A to the nozzle **8** through the aperture **12** and the pressure chamber **10** is formed in the head body **70**A in accordance with every pressure chamber **10**.

The head body **70**A has a laminated structure in which ten sheet materials in total are laminated on one another, that is, an actuator unit **21**, a cavity plate **22**, a base plate **23**, an aperture plate **24**, a supply plate **25**A, manifold plates **26**A, **27**A and **28**A, a cover plate **29** and a nozzle plate **30** are laminated successively in descending order. The ten sheet materials except the actuator unit **21**, that is, nine metal plates form a flow path unit **4**A. The respective metal plates are collectively bonded to one another by means of diffusion junction.

The actuator unit **21** includes a laminate of four piezoelectric sheets **41** to **44** as four layers, and electrodes disposed so that only the uppermost layer is provided as a layer having a portion serving as an active layer at the time of application of electric field while the residual three layers are provided as non-active layers. The cavity plate **22** is a metal plate having a large number of approximately rhomboid openings corresponding to the pressure chambers **10**. The base plate **23** is a metal plate which has holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding aperture **12**, and holes each for connecting the pressure chamber **10** to a corresponding ink nozzle **8**. The aperture plate **24** is a metal plate which has apertures **12** formed as half-etching regions each for connecting two holes in one pressure chamber **10** of the cavity plate **22**, and holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**. The supply plate **25**A is a metal plate which has holes each for connecting an aperture **12** for one pressure chamber **10** of the cavity plate **22** to a corresponding sub manifold **5***a*A, and holes each for connecting the pressure chamber **10** to the ink nozzle **8**. The supply plate **25**A is formed to be the thickest among the metal plates constituting the flow path unit **4**. The thickness of the supply plate **25**A is selected so that the supply plate **25**A is not curved toward the sub manifold **5***a*A side by the pressure applied at the time of diffusion junction. The manifold plates **26**A, **27**A and **28**A are metal plates which have holes **26***c*A, **27***c*A and **28***c*A connected to one another at the time of lamination for forming the sub manifolds **5***a*A, and holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**. The cover plate **29** is a metal plate which has holes each for connecting one pressure chamber **10** of the cavity plate **22** to a corresponding ink nozzle **8**. The nozzle plate **30** is a metal plate which has nozzles **8** each provided for one pressure chamber **10** of the cavity plate **22**.

These nine metal plates are laminated on one another while positioned so that individual ink flow paths **32**A as shown in FIG. **10** are formed. Each of the individual ink flow paths **32**A first extends upward from the sub manifold **5***a*A, extends horizontally in the aperture **12**, extends further upward, extends horizontally in the pressure chamber **10** again, extends obliquely downward for a while in a direction of departing from the aperture **12** and extends vertically downward to the nozzle **8**.

Each sub manifold **5***a*A serving as an ink flow path is formed from the three holes **26***c*A, **27***c*A and **28***c*A of the manifold plates **26**A, **27**A and **28**A as described above. The sectional shape of each sub manifold **5***a*A in the widthwise direction is like a rectangle in which the length in the widthwise direction (width) is larger than the length in the direction of lamination of the metal plates (height).

According to the second embodiment described above, the supply plate **25**A having the aforementioned thickness is laminated so as to be adjacent to the manifold plate **26**A having the holes **26***c*A as large openings in regions adjacent to the sub manifolds **5***a*A respectively. For this reason, the supply plate **25**A is not curved convexly toward the sub manifold **5***a*A side by the pressure applied in the direction of the thickness of the respective metal plates when the respective metal plates are fixed to one another by metal-metal junction. Accordingly, there is neither formation of a gap between the supply plate **25**A and the aperture plate **24** nor deformation in inner shape of the ink flow paths of the apertures **12** constituted by the supply plate **25**A and the aperture plate **24**. As a result, even in the case where the sub manifolds **5***a*A are formed in the inside of the metal plates, the metal plates adjacent to the sub manifolds **5***a*A can be fixed to one another by metal-metal junction surely.

Although the second embodiment has been described on the case where the sectional shape of each sub manifold **5***a*A is like a rectangle in which the length in the widthwise direction (height) is larger than the length in the direction of lamination of the metal plates (width), the shape of each manifold **5***a*A is not limited thereto. FIG. **11** is a sectional view showing a modification of the head body **70**A. For example, as shown in FIG. **11**, the sectional shape of each sub manifold **5***a*A may be like a rectangle in which the length in the widthwise direction (width) is smaller than the length in the direction of lamination of the metal plates (height). According to this modification, the gap can be prevented from being formed between the supply plate **25**A and the aperture plate **24** while the inner shape of the ink flow paths of the apertures **12** constituted by the supply plate **25**A and the aperture plate **24** can be prevented from being deformed.

Although preferred embodiments of the invention have been described above, the invention is not limited to the embodiments and various changes may be made without departing from the scope of claim. For example, though the first embodiment has shown the configuration in which each sub manifold **5***a* is formed from the holes **26***c*, **27***c* and **28***c* of the three manifold plates **26**, **27** and **28**, the invention is not limited to the configuration. Each sub manifold **5***a* may be formed from holes of two or less metal plates or from holes of four or more metal plates. Incidentally, when each sub manifold **5***a* is formed from a hole of one metal plate, the sectional area, in the planar direction, of the hole of the metal plate used for forming the sub manifold **5***a* is set so as to increase when viewed from the aperture plate **24** side to the cover plate **29** side.

Although the second embodiment has shown the configuration in which the supply plate **25**A is the thickest among the metal plates constituting the flow path unit **4**A, the invention is not limited to the configuration but may be also applied to a configuration in which a metal plate other than the supply plate such as the base plate is the thickest among the metal plates constituting the flow path unit **4**A. As described in the first embodiment, the sectional areas, in the planar direction, of the holes of the metal plates constituting the sub manifold **5***a*A may be formed so as to increase when viewed from the aperture plate **24** side to the cover plate **29** side.

Although the first and second embodiments have shown the configuration in which the metal plates are bonded to one another by means of diffusion junction, the invention is not limited to the configuration. For example, the metal plates may be bonded to one another by solder bonding. Incidentally, when solder bonding is used, metal plates such as copper-plated, silver-plated or gold-plated metal plates good in wettability to solder or stainless steel plates containing at least one of these elements are bonded to one another at a high temperature in a vacuum atmosphere.

According to one aspect of invention, the inkjet printing head includes a common ink chamber, and individual ink flow paths for leading ink from an outlet of the common ink chamber to nozzles through pressure chambers respectively, the common ink chamber and the individual ink flow paths being formed in such a manner that a plurality of thin plate members having holes are fixed to one another by metal-metal junction while laminated on one another, wherein the sectional area of the common ink chamber along a planar direction of the plurality of thin plate members is configured so that the sectional area at an end portion on the outlet side of the common ink chamber is smaller than the sectional area in a central portion in a direction of thickness of the plurality of thin plate members.

According to the configuration of the above, pressure applied in the direction of the thickness of the thin plate members when the thin plate members are fixed to one another by metal-metal junction in regions adjacent to the common ink chamber is diffused to the thin plate members constituting the common ink chamber. Accordingly, the thin plate members can be prevented from being curved (convexly toward the common ink chamber). Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided. As a result, even in the case where the common ink chamber is formed in the inside of the thin plate members, the plurality of thin plate members adjacent to the common ink chamber can be fixed to one another by metal-metal junction surely.

preferably, in the configuration, the sectional area of the common ink chamber along a planar direction of the plurality of thin plate members is configured so that the sectional area at an end portion on the outlet side of the common ink chamber is smaller than the sectional area in a central portion in a direction of thickness of the plurality of thin plate members while the sectional area in the vicinity of the other end portion is larger than the sectional area in the vicinity of the central portion. According to this configuration, the pressure can be more largely diffused to the thin plate members constituting the common ink chamber. Accordingly, the thin plate members can be prevented from being curved (convexly toward the common ink chamber). Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided more sufficiently.

The sectional area of the common ink chamber along a planar direction of the plurality of thin plate members may change stepwise in three or more stages at one end portion on the outlet side of the common ink chamber or may change continuously at one end portion on the outlet side of the common ink chamber. According to this configuration, prevention of formation of a gap between the thin plate members can be easily combined with keeping of the volume of the common ink chamber.

Preferably, the common ink chamber may be formed in such a manner that the holes formed in the plurality of thin plate members laminated adjacently on one another are connected to one another. According to this configuration, the common ink chamber can be produced easily.

According to another aspect of the invention, the inkjet printing head includes a common ink chamber, and individual ink flow paths for leading ink from an outlet of the common ink chamber to nozzles through pressure chambers respectively, the common ink chamber and the individual ink flow paths being formed in such a manner that a plurality of thin plate members having holes are fixed to one another by metal-metal junction while laminated on one another, wherein the thickest one of thin plate members adjacent to the thin plate members constituting the common ink chamber in the direction of lamination is located between the central position of the plurality of thin plate members in the direction of lamination and the common ink chamber.

According to the configuration of the above, the thickest thin plate member is hardly deformed by pressure applied in the direction of the thickness of the thin plate members when the plurality of thin plate members are fixed to one another by metal-metal junction in regions adjacent to the common ink chamber. Accordingly, the thin plate members can be prevented from being curved (convexly toward the common ink chamber). Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided. As a result, even in the case where the common ink chamber is formed in the inside of the thin plate members, the plurality of thin plate members adjacent to the common ink chamber can be fixed to one another by metal-metal junction surely.

Preferably, in the above configuration, the thickest thin plate member may be configured to serve as a wall of the common ink chamber. According to this configuration, pressure is concentrated on the thickest thin plate member. Accordingly, the thin plate members can be prevented from being curved. Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided more sufficiently.

The common ink chamber may extend along the pressure chambers and may have such a shape that the length of the common ink chamber in the direction of lamination is larger than the width of the common ink chamber in a direction perpendicular to the direction of extension. According to this configuration, the phenomenon that a gap is formed between the thin plate members because of distortion of the thin plate members can be avoided more sufficiently.

In the inkjet printing head according to the embodiments described above, rate of change of the sectional area of the common ink chamber (manifolds **5**) may be configured to be larger at one side where the pressure chamber **10** is disposed than at an opposite side positioned oppositely to the one side with respect to the outlet, as shown in FIG. **12**. According to this configuration, the thin plate members can be prevented from being curved (convexly toward the common ink chamber). Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided. As a result, even in the case where the common ink chamber is formed in the inside of the thin plate members, the plurality of thin plate members adjacent to the common ink chamber can be fixed to one another by metal-metal junction surely.

According to the invention, an inkjet printing head having a structure shown in FIG. **13** is also attained. The inkjet printing head shown in FIG. **13** has a structure including: a common ink chamber having an outlet; and an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber. The common ink chamber and the individual ink flow path are formed of a plurality of thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction. And, sectional area of the common ink chamber along a planar direction of the thin plate members is configured to be smaller at an end portion where the outlet is provided than at a central portion in a direction of thickness of the plurality of thin plate members. In the configuration shown in FIG. **13**, a thickest one of a part of the plurality of thin plate members that are laminated above the common ink chamber at a side to the pressure chamber, is positioned at a side to the common ink chamber in the part of the plurality of thin plate members with respect to a central position of the part of the plurality of thin plate members.

According to the configuration shown in FIG. **13**, the thin plate members can be prevented from being curved (convexly toward the common ink chamber). Accordingly, the phenomenon that a gap is formed between the thin plate members or the inner shape of ink flow paths formed between the thin plate members is deformed can be avoided. As a result, even in the case where the common ink chamber is formed in the inside of the thin plate members, the plurality of thin plate members adjacent to the common ink chamber can be fixed to one another by metal-metal junction surely.

The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiments were chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

What is claimed is:

1. An inkjet printing head comprising:

a common ink chamber having an outlet; and

an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber,

wherein the common ink chamber and the individual ink flow path are formed of a plurality of metal thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction, and

wherein sectional area of the common ink chamber along a planar direction of the thin plate members is configured to be smaller at an end portion where the outlet is provided than at a central portion in a direction of thickness of the plurality of thin plate members.

2. The inkjet printing head according to claim 1, wherein the sectional area of the common ink chamber is configured to be larger at the other end portion opposite to the end portion than at the central portion.

3. The inkjet printing head according to claim 2, wherein each hole, formed on the plurality of thin plate members and forms the common ink chamber, is configured such that the size of each hole increases from the hole provided at the side of the outlet towards the opposite side of the common ink chamber.

4. The inkjet printing head according to claim 1, wherein the sectional area of the common ink chamber is configured to be changed stepwise in three or more stages at the end portion.

5. The inkjet printing head according to claim 1, wherein the sectional area of the common ink chamber is configured to be changed continuously at the end portion.

6. The inkjet printing head according to claim 1, wherein the common ink chamber is formed by the holes being connected to one another.

7. The inkjet printing head according to claim 1, wherein rate of change of the sectional area of the common ink chamber is configured to be larger at one side where the pressure chamber is disposed than at an opposite side positioned oppositely to the one side with respect to the outlet.

8. The inkjet printing head according to claim 1, wherein a thickest one of a part of the plurality of thin plate members that are laminated above the common ink chamber at a side to the pressure chamber, is positioned at a side to the common ink chamber in the part of the plurality of thin plate members with respect to a central position of the part of the plurality of thin plate members.

9. The inkjet printing head according to claim 8, wherein the thickest thin plate member serves as a roof of the common ink chamber.

10. The inkjet printing head according to claim 8, wherein the plurality of thin plate members include:

a cavity plate on which formed a hole corresponding to the pressure chamber;

a supply plate on which formed a hole corresponding to the outlet and configured to be the thickest thin plate member; and

an aperture plate on which formed a hole corresponding to a restricted flow path that restricts flow of the ink and provided between the common ink chamber and the pressure chamber in the individual ink flow path, the aperture plate being laminated at a position between the cavity plate and the supply plate.

11. The inkjet printing head according to claim 8, wherein a plurality of the pressure chambers are arranged in a matrix, and

wherein the common ink chamber is provided to extend in a direction along the pressure chambers and has a sectional shape in which a length in a direction of the lamination of the plurality of thin plate members is larger than a length in a direction perpendicular to the direction of extension thereof.

12. An inkjet printing head comprising:

a common ink chamber having an outlet; and

an individual ink flow path having a pressure chamber and leads ink from the outlet of the common ink chamber to a nozzle through the pressure chamber,

wherein the common ink chamber and the individual ink flow path are formed of a plurality of thin plate members having holes formed thereon, the thin plate members being laminated and fixed onto one another by metal-metal junction, and

wherein a thickest one of a part of the plurality of thin plate members that are laminated above the common ink chamber at a side to the pressure chamber, is positioned at a side to the common ink chamber in the part of the plurality of thin plate members with respect to a central position of the part of the plurality of thin plate members.

13. The inkjet printing head according to claim 12, wherein the thickest thin plate member serves as a roof of the common ink chamber.

14. The inkjet printing head according to claim 12, wherein the plurality of thin plate members include:

a cavity plate on which formed a hole corresponding to the pressure chamber;

a supply plate on which formed a hole corresponding to the outlet and configured to be the thickest thin plate member; and

an aperture plate on which formed a hole corresponding to a restricted flow path that restricts flow of the ink and provided between the common ink chamber and the pressure chamber in the individual ink flow path, the aperture plate being laminated at a position between the cavity plate and the supply plate.

15. The inkjet printing head according to claim 12, wherein a plurality of the pressure chambers are arranged in a matrix, and

wherein the common ink chamber is provided to extend in a direction along the pressure chambers and has a sectional shape in which a length in a direction of the lamination of the plurality of thin plate members is larger than a length in a direction perpendicular to the direction of extension thereof.

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